SCIENCE ABSTRACTS.

Section A.—PHYSICS.

AUGUST 1920.

GENERAL PHYSICS.

1030. *Experiments with a New Micro-balance.* **H. Pettersson.** (Phys. Soc., Proc. 32. pp. 209–221, June, 1920).—*Previous Micro-balances.*—Brief reference is made to the instruments of Ångström, Salvioni, Nernst, and especially to the all-quartz balance of Steele and Grant.

The Author's Micro-balance.—The instrument devised by the author, and here described, is also wholly of quartz. The knife-edge support is, however, replaced by a suspension consisting of a pair of quartz fibres. A magnetic arrestment is employed. Balance is obtained either (*a*) by an "air-weight," the upward displacement on a bulb being varied by varying the gas pressure within the enclosing case; or (*b*) by a "magnetic weight," involving the use of a measured electric current. The range of weighings depends on the size of beam; with one 5 cm. in length the max. load is between 100 and 200 mgm., and the setting can be made to within 10^7 mgm.

The Strömberg Suspension.—Improvements in the construction devised by Strömberg are described, which obviate the formidable difficulties of manipulation that have hitherto discouraged workers from employing the instrument.

Investigations with the Fibre-suspended Micro-balance.—A brief description is given of the following researches already carried out:—(1) The influence of temperature upon weight. This is an extension of the work of Poynting and Phillips on this subject; (2) the volatility of silica; and (3) the susceptibility of diamagnetic bodies.

It is proposed to conduct investigations on the pressure of light, on the measurement of absolute temperature (based on an equation of Knudsen's), and on the loss of mass accompanying loss of energy.

AUTHOR.

1031. *Hot-wire Anemometer for finding Velocity of Gases in Pipes.* **J. S. G. Thomas.** (Phys. Soc., Proc. 32. pp. 196–205; Disc., 205–207, April, 1920. Phil. Mag. 39. pp. 505–534, May, 1920.)—Gives in detail the construction of the hot-wire anemometer described by King [see Abs. 807 (1915)] and Morris. When employing a vertical flow tube and a downward stream of gas, it was found that the temperature of the hot wire attained a maximum which, presumably, corresponded with the condition under which the cooling of the wire by the free convection current was just neutralised by the effect of the impressed air-stream. A table is given showing that for wire temperatures of 135° to 677° C. the velocity of the convection current ranges from 3·1 to 15·9 cm. per sec.

The second part of the paper describes the double exposed-wire directional anemometer devised by the author. This consists of two Pt wires parallel with one another and separated by about 0·5 mm. They are inserted into the flow tube so that the wires are at right angles to the direction of flow of the gas-stream. The wires form two arms of a Wheatstone bridge in which a constant current is maintained. The indications of the anemometer depend upon the fact that the heated wire, upon which the gas-stream is first incident, exercises a shielding influence upon the cooling effect experienced by the second wire, the gas incident upon the latter having been already heated somewhat by passage over the first wire. Hence the direction of deflection of the galvanometer will be to left or right according to the direction of flow of the gas in the tube. Calibrations of a directional anemometer of this type were made with the flow-tube arranged vertically and horizontally. With a vertical flow-tube, the air-stream was directed in a downward and in an upward direction in separate experiments. The results obtained in the calibration are given in graphical form in the paper. For use with certain gases a form of hot wire consisting of a Pt wire coated with a very thin layer of glass may be used. J. W. T. W.

1032. *On Balancing Errors of Different Orders.* **T. Smith.** (Phys. Soc., Proc. 32. pp. 141–153; Disc., 153, April, 1920.)—In calculating functions from Taylor expansions or otherwise, the results obtained by summing any finite number of terms will differ to a greater or less extent from the true results. It is shown in the paper that by suitable modifications of the coefficients the results obtained, even when comparatively few terms of the expansion are taken, can be made to approximate very closely to the true results for all values of the variable between selected limits. AUTHOR.

1033. *Elastic After-effect and Elastic Hysteresis in Metals.* **G. Masing.** (Deutsch. Phys. Gesell., Verh. 21. pp. 686–691, Dec. 5, 1919.)—Detailed consideration of the phenomena occurring during the deformation of metallic crystals by slipping points to their being too complicated and too little investigated to allow of a clear conception of their mechanism at the present time.

Wartenberg's theory of elastic after-effect [Abs. 828 (1919)] has been extended, and it is shown that modern metallography does provide an explanation of elastic hysteresis, *i.e.*, the phenomenon of steady residual deformation. During the "return" deformation (elastic after-effect) the stress does not return to zero, but there remains a small residual stress which gives rise to the elastic hysteresis. The elastic after-effect occurs only in conglomerates of crystals, and is due to the capacity for resisting deformation, being different in different directions. Since in amorphous materials like glass there are always locally stressed areas, it seems likely that the after-effect in such bodies admits of an explanation similar to that for the effect in crystalline materials. F. C. A. H. L.

1034. *Velocity Distribution in Tank with Orifice.* **C. Camichel.** (Comptes Rendus, 170. pp. 986–988, April 26, 1920.)—It is shown that,

in order to know the distribution of the velocities in the mass of fluid in a tank provided with a small thin-edged orifice, it is sufficient to determine the vertical distribution of the velocities. The experimental verification of this pronciple was obtained by the method of photographing the stream-lines, when charged with light powder. A study of the velocity curves so obtained reveals the existence of two hydraulic states: one, characterised by continual velocity variation at a point, and the other by constant magnitude and direction of the velocity at a point. The latter may be termed the non-turbulent regime, and under it energy losses are much reduced. [**Errata** (*Ibid.*, p. 1136, May 10, 1920).]
W. A. R.

1035. *Kelvin's Principle of Images in Hydraulics.* **C. Camichel.** (Comptes Rendus, 170. pp. 1106–1107, May 10, 1920.)—In order to obtain completely the distribution of velocities in a tank provided with a thin-edged orifice, it is sufficient to determine the equipotential surfaces due to two assumed electrical masses of the same sign, symmetrically placed with respect to a vertical wall parallel to one of the walls of the tank, and to consider only the fluid on one side of this wall. The principle was demonstrated by the photographic method. W. A. R.

1036. *The Falling-Sphere Viscosimeter.* **W. H. Gibson** and **L. M. Jacobs.** (Chem. Soc., J. Trans. 117. pp. 473–478, May, 1920.)—The theory of the falling-sphere viscosimeter is discussed, the magnitude of certain corrections and errors indicated, and the bearing of these considerations on the design of an instrument outlined. Such an instrument has been in use for over three years in Government laboratories for the comparison of nitrocellulose solutions, and it is now found to give accurate results for the viscosity of castor oil. T. H. P.

1037. *Causality and Relativity Theories.* **J. Petzoldt.** (Zeits. f. Physik, 1. 5. pp. 467–474, 1920.)—While natural processes cannot at present be ascribed to the absolute motions of material substances in Euclidean space under the action of absolute forces, the older conception has not been allowed to lapse since the relativity theory is not yet completely developed. In consequence a series of intermediate standpoints between the old and new theories have been proposed. The present paper deals with such an attempt at reconciliation by Holst [see Abs. 968 (1920)]. The latter disputes the equality of the relative coordinate systems, the fixed-star system being held superior to all the others. As a result of the gravitational field of all the members of the fixed-star system, a homogeneous neutral field exists which is the carrier of the primary Inertial system. From this Holst deduces a valid causality for all observers. His theory is designated by the present writer as a modified Lorentz neutral field hypothesis, and regarded as only a picture of real and hypothetical processes. Comparison is made between the Holst and Einstein theories, in the light of Hertzian conceptions. Minkowski's work on space and time is quoted since it is based on experimental grounds, namely, the experiments of Fizeau and Michelson, neither of which were in consonance with the ether theories without changing the usual conceptions of space and time. Einstein's view of the velocity of light is shown to be more valid than the absolute conception of Lorentz, and Holst's conclusions are now shown to weaken the Lorentz theory and not that of Einstein. The author points out the influence of metaphysical forms of argument on the present situation, especially in dealing with the problem of the finite or infinite character of the universe. He opines that the revolution from belief in a transcendent mechanical nature to conviction of the immanent reality of phenomena cannot be saved by a compromise between mechanics and relativity theory. H. H. Ho.

1038. *Does the Relativity Theory render the Causal Idea invalid?* **H. Holst.** (Zeits. f. Physik, 1. 1. pp. 32–39, 1920.)—This paper is in response to two recent articles by Petzoldt [see Abs. 534 and 1468 (1919)], in which an extension is proposed of the relativity theory. In the first article dealing with dimensional change and permanence of physical process, Petzoldt opines that not only the older conception of force but also the causal idea must be rejected. In the second article he lays down that a decision as to the basis of the relativity theory may be obtained from the possibility of its representation by means of a mechanical model. Petzoldt denies this possibility. According to the present author when the different coordinate systems of the observers moving uniformly with respect to each other are physically identical then the above assertions must be admitted, and on this assumption the situation can scarcely be characterised in a better and shorter manner than that employed by Petzoldt. If, however, the subject be regarded from the standpoint of the general theory of relativity, then in the author's opinion this assumption is not justified. The retention of the ether idea is discussed but found to afford no help, the root of the problem being whether the different systems of coordinates are physically equal or not. Einstein has found in his development of the general relativity theory that the separate position of the inertial system requires a causal basis, and, in accord with Mach, he has postulated distant masses as the main cause of the different behaviour of bodies in inertial systems and other systems of coordinates. Proceeding on a similar line of investigation the author finds that Einstein's principle does not contradict the causal hypothesis but may be regarded as a mathematical transformation of it. H. H. Ho.

1039. *Deterioration of Visibility in Paris.* **L. Besson.** (Comptes Rendus, 170. pp. 123–125, Jan. 12, 1920.)—Visibility from the summit of a tower in Paris, in the four cardinal directions, has been observed several times a day for the last 25 years under identical conditions. For each of the observations made at 9h., 12h., and 15h., the mean of the visibility in the four directions is now taken. Three degrees of transparence are distinguished: (1) above 6 km., (2) 6 km. to 1·5 km., (3) below 1·5 km. Tables show for each year, in two seasons, and for each hour of observation the frequency of these three degrees. Quinquennial means are added. The outstanding result is that visibility deteriorated gradually during the first twenty years and enormously during the war. M. A. G.

1040. *Pilot-Balloon Ascents at Gâvre.* **F. La Porte.** (Comptes Rendus, 170. pp. 279–282, Feb. 2, 1920.)—The paper sets out some conclusions drawn from the results of pilot-balloon ascents made at Gâvre. The balloons used were of mean weight 80 gm. and were observed by theodolite simultaneously from three posts connected by telephone, readings being taken at intervals of 30 secs. at signals given from the post at which the balloons were liberated. Calculation then gave three solutions for the height of the balloon at each time of reading and good agreement was found between them. The rate of ascent is in general greatest at first and decreases more or less rapidly up to a certain height, after which a constant velocity is attained. The height at which this occurs varies with the meteorological conditions and is at Gâvre, on an average, 500 m. in winter and 1000 m. to 1500 m. in summer. In the constant zone the mean rates of ascent for free lifts varying from 150 gm. to 400 gm. agree well with the values deduced from the formula $V = 90F^{1/2}/(F + P)^{1/3}$ which is Dines's formula with constant 90 instead of 84. [The constant 84 was obtained experimentally with balloons of weight not exceeding 30 gm.]. Here V is the rate of ascent in metres per minute, P the dead weight of the balloon, and F the free lift in gm. Rouch's formula $V = 42F/(F + P)^{2/3}$ does not give such good results.

M. A. G.

1041. *Variation of the Indications of Robinson and Richard Anemometers with the Inclination of the Wind.* **C. E. Brazier.** (Comptes Rendus, 170. pp. 610–612, March 8, 1920.)—Robinson and Richard anemometers have been exposed, in an aerodynamical laboratory, to wind currents of known velocity making various angles with the normal position in which the instrument is used, and some preliminary results are noted in this paper. The number of revolutions per second (n) in the normal position is found to be related to the wind velocity (V) by a relation of the form $V = A + Bn$ for the Robinson anemometer and $n = aV + bV^2 + cV^3$ for the Richard. The term in V^3 may be omitted by reducing the size of the Richard instrument. If the instruments are inclined to their normal position at angles up to 30° it is found sufficient to modify the above relations, expressed in the form $n = \phi(V)$, simply by multiplying $\phi(V)$ by a factor. For an inclination of 30° the factors found are 1·1 for the Robinson anemometer and 0·8 for the Richard. The experiments show that, for a given wind velocity, the variation in the velocity of rotation is not a simple function of the inclination of the instrument to the normal position, and the effect of increasing the inclination up to 90° is shown by an example for each instrument. A description is added of the effect of exposing an element of a Robinson anemometer (2 cups only) in the normal position to a stream of air velocity 5 m./sec. Four positions of equilibrium are found, two stable and two unstable. Commencing with a position of stable equilibrium and increasing the velocity of the air, the system after oscillating finally rotates continuously in the ordinary sense.

M. A. G.

1042. *Composition of the Atmosphere.* **A. Krogh.** (K. Danske Vidensk. Selskab. 1. No. 12. pp. 1–19, 1919.)—With the apparatus briefly described absolute determinations of CO_2, O, "N" (N + inert gases), and combustible gases may be made with an accuracy of 0·001%. The percentage of combustible gases (whether hydrogen or not) is found to be below 0·0005% and probably below 0·0002%, much less than the commonly assumed value 0·003%. "N" is very nearly constant, observed variations from the average being less than 0·003%, and it is claimed that the average "N" percentage in the troposphere is a geophysical constant which can be ascertained within 0·001%. Two analyses give the absolute composition at the surface as 0·030% CO_2, 79·022% "N," and 20·948% O. In the streets of Copenhagen the CO_2 percentage is usually increased by 0·001–0·007% above the normal 0·030%, there being at the same time a deficit of oxygen. The author urges a thorough study, by the methods developed, of the composition of atmospheric air including samples from great heights. The paper is printed in English. M. A. G.

1043. *The Primitive Ocean.* **C. Gorceix.** (Comptes Rendus, 170. pp. 943–946, April 19, 1920.)—Granted that there was a primeval deluge when the earth's temperature reached the critical temperature for water, there are three possible hypotheses as to the origin of the ocean basins. (1) Under the influence of unknown forces, a wrinkling of the crust existed before the deluge, in the hollows of which the water collected. (2) The surface was regular, and hollows were produced after the deluge by unknown forces. (3) The water fell around the South Pole excavating gigantic hollows, whose debris, washed northwards, formed the continental basins. This third view alone is shown on analysis to give isostatic equilibrium. W. A. R.

1044. *Estuary Tides by Projection.* **A. N. Shaw, V. Henry,** and **B. Dawson.** (Roy. Soc. Canada, Trans. 13. Sect. 3. pp. 139–151, 1919.)—The analysis of simple periodic curves by projection methods is described. The curve to be projected is cut in cardboard, mounted on a frame by means of which it may be inclined to any position, and projected by a beam of light on to a glass plane, where it may readily be traced. The method is applied to the analysis of estuary tides. It appears probable that any tidal graph for one tide may very approximately be obtained by projection from one wave-length of a pure sinusoid, the transformation involving three parameters. Also tidal graphs for any place on an estuary may, in some cases, be obtained by the projection of the tidal graphs at some other place on the estuary, only two parameters being required. The association of the parameters, which are needed in the projection method, with the physical tide factors is discussed. W. A. R.

1045. *Ocean Turbulence.* **H. Jeffreys.** (Phil. Mag. 39. pp. 578–586, May, 1920.)—The theory that the main ocean currents are due to volume changes caused by temperature differences is inadequate, since the horizontal forces on the air and the wind should be in opposite directions. This is not even approximately true. If the general circulation of the ocean be regarded as directly due to the trade winds, the currents should be perpendicular to the wind, but this also is not true. The problem is complicated by the effects of ocean turbulence, and the problem is here analysed from this standpoint. It is shown that in the northern hemisphere the surface current should be inclined 45° to the wind, flowing towards the greater pressure. The velocity diminishes in magnitude with the depth and rotates clockwise. The same statement applies to the southern hemisphere, but the current rotates anti-clockwise. These results closely agree with the observations available. The turbulence is attributed to wave motion, and this accounts for the way it dies out with depth. The rate of dissipation of tidal energy by skin friction in the open ocean is of the order 10^{16} ergs per sec., compared with Taylor's figure of 3×10^{17} ergs per sec. in the Irish Sea. Thus the influence of tides in the open ocean on the moon is insignificant compared with that of tides in partly enclosed seas. W. A. R.

1046. *Mean Density of the Earth.* **E. B. Lera.** (N. Cimento, 19. pp. 129–139, March, 1920.)—The methods hitherto used imply that the earth is a homogeneous sphere at rest, and ignore the component of force due to terrestrial rotation. In 1849 Stokes showed how to determine approximately the potential of the earth and the force at any point on the assumption that the surface of the earth is a surface of equilibrium, an ellipsoid of revolution round the axis of rotation. In 1894 Pissetti (Accad. Lincei, Atti, 1894) reached, on the same assumptions, an exact expression for the acceleration G of gravity at a point on the earth's surface, latitude ϕ, namely:

$$G=\frac{\gamma M}{b^2}\sqrt{1+\varepsilon^2\cos^2\phi}+\frac{\dfrac{\omega^2 bB}{\sqrt{1+\varepsilon^2}}\left(1-\dfrac{3+\varepsilon^2}{2}\cos^2\phi\right)-\omega^2 b\sqrt{1+\varepsilon^2}/\cos^2\phi}{\sqrt{1+\varepsilon^2\cos^2\phi}},$$

where γ is the constant of gravitation, M the total mass of the earth (however distributed), ω the angular velocity of rotation, b the equatorial semi-axis, $\varepsilon = e/\sqrt{1-e^2}$ where e is the eccentricity of the meridional ellipse, and

$$B=\frac{2(1+\varepsilon^2)(\varepsilon-\tan^{-1}\varepsilon)-\frac{2}{3}\varepsilon^3}{(3+\varepsilon^2)\tan^{-1}\varepsilon-3\varepsilon}.$$

On the other hand Helmert by collating the observational results has deduced the expression:

$$G = 978\cdot046\left\{1 + \cdot0^{2}5302\sin^2\phi - \cdot0^{5}7\sin^2 2\phi\right\}.$$

Equating the results of Pissetti and Helmert, and using Bessel's values for the form of the earth, the author deduces

$$\gamma M = \frac{979\cdot843 + 3\cdot297\cos^2\phi - \cdot0^{2}136\cos^4\phi}{\sqrt{1+0\cdot0^{2}671922\cos^2\phi}}\,b^2$$
$$= (3\cdot985156 \pm \cdot0^{4}99)\times 10^{20}.$$

The mean value of γ is $6\cdot67 \times 10^{8}$ within 1 %. This mean value would give $M = 5\cdot97 \times 10^{27}$, whence the mean density of the earth would be 5·51 within 1 %. A. D.

1047. *Tests of 100-inch Hooker Telescope.* **G. E. Hale.** (Nature, 105. pp. 266–268, April 29, 1920.)—Since the light-grasping power varies as the area of the aperture and the resolving power as the diameter, the 100-in. should have 2·8 times the light-grasp and 1·7 times the resolving power of the 60-in., and so can be used for stars a whole magnitude fainter, and can be expected to show much finer detail of the filament structure of nebulæ and of the markings on the moon, and to separate very close binaries. It has increased very much the number of stars whose spectrograms can be obtained, *e.g.*, long-period variables of the Md class, and, with low dispersion, stars of 14th magnitude in clusters. It has also been used to show fine detail in nebulæ, and by Michelson's interference method to obtain visual observations of Capella as a binary. In no direction has the instrument disappointed expectation. W. W. B.

1048. *Sun-spot and Facula Disturbance near Eclipse Prominence of 1919.* **H. W. Newton.** (Roy. Astron. Soc., M.N. 80. pp. 463–467, March, 1920.)—It has been declared by Pettit and Evershed [see Abs. 338 (1920)] independently that the eruptive prominence of May 29 was definitely connected with sun-spots. The author carefully traces the history of the region from May 3 to July 3, from the Greenwich photographs, and finds nothing unusual in it, the spot being quiescent and the base of the prominence in a region free from spots or faculæ. He therefore concludes that there is practically no evidence of a causal relationship between the spot and the prominence. W. W. B.

1049. *Advance of Perihelion of Planet, and Path of Light Ray in Sun's Gravitation Field.* **A. Anderson.** (Phil. Mag. 39. pp. 626–628, May, 1920.)—Using the same particular integral of Einstein's contracted tensor equations, which has been applied to the case of the motion of a planet in the sun's gravitational field, the author obtains a suitable equation by substituting $(2r + m)^2/4r$ for r therein, and from this obtains the p and r equation of the path of the ray, neglecting squares of m/r, $p(1 + 2m/r) = a + 2m$, where m is the astronomical mass of the sun, and a is the distance of the sun's centre from the apse. Now if it be legitimate to make the above substitution in obtaining this, it should also be so to go back to the case of the planet and make the same change. But the resulting equation reduces to the ordinary Newtonian equation for elliptic motion, leaving the advance of Mercury's perihelion unexplained. G. W. DE T.

1050. *Influence of Small Changes of Temperature on Atmospheric Refraction.* **A. Schuster.** (Phys. Soc., Proc. 32. pp. 135–140; Disc., p. 141, April, 1920.)—The paper is an investigation of the possible deviation of the light from a star near the sun due to the temperature changes in the atmosphere produced by the passage of the moon's shadow across the earth during an eclipse. It is shown that while the actual displacements from this cause vary widely for slight differences in the assumed conditions, they are always negligibly small compared with the effects observed at the last solar eclipse. AUTHOR.

1051. *Observed Changes in Colour of Jupiter's Equatorial Zone.* **A. S. Williams.** (Roy. Astron. Soc., M.N. 80. pp. 467–475, March, 1920.)—Search through observations of the last 150 years shows that the tawny colour has made its appearance on seven occasions in the equatorial zone, indicating a regular period of 11·95 years, probably identical with that of Jupiter's revolution about the sun. The tawny colour appears shortly before aphelion, and lasts for about three years. The colour is now apparent in the equatorial zone, and the max. colouration is due towards the end of 1920. W. W. B.

1052. *Comet 1919b, and Rejection of a Comet's Tail.* **E. E. Barnard.** (Astrophys. J. 51. pp. 102–106, March, 1920.)—This is a return of Brorsen's comet, 1874 V, and is interesting historically and because of its tails. In Sept. and Oct. 1919 it was a dim, hazy tailless naked-eye star, of max. brightness corresponding to 4·5 magnitude. Of twelve photographs taken, early ones show a slender tail several degrees long. Later the comet became active, and about Oct. 20 discarded its tail and developed a new one, making an angle of 12° with the old. Similar phenomena were observed in connection with Borrelly's comet of 1903, Morehouse's of 1908, and Halley's of 1910. Stereoscopic views of the second of these showed the rejection to be associated with a cyclonic disturbance. Other features are described characteristic of various stages of the phenomenon. W. W. B.

1053. *Comets with Small Perihelion Distance, and the Resisting Medium.* **A. C. D. Crommelin.** (Roy. Astron. Soc., M.N. 80. pp. 475–477, March, 1920.)—To test the effect of density close to the sun, all comets with perihelion distance less than the sun's radius are examined. They are five in number: 1680, 1843 I, 1880 I, 1882 II, and 1887 I. The last four probably have a common origin, and were very bright at perihelion, so that they could hardly come back unobserved. They showed practically no diminution of velocity after perihelion. In no case can the velocity of even the quickest have fallen off more than 1 part in about 4000. The comets were within a distance of a solar radius from the sun for about two hours with velocity about 300 miles per sec., so if the density encountered by them were comparable with that which incandesces meteors travelling only 30 miles a second, 100 miles up in the earth's atmosphere, the comets could not survive. The density must therefore be exceedingly small. W. W. B.

1054. *Spectrum of γ Argo.* **W. M. W[orsell].** (Union Observat. of S. Africa, Circ. No. 46. p. 20, July 7, 1919.)—No physical change was found on comparing plate taken on 1919 March 25 with one on 1915 April 29. Four specially broad bands were measured, λλ 7176, 7043, 6735, and 6666, the first an absorption band, the others emission, but the spectrum was very dense and the measures are not of very great accuracy. W. W. B.

1055. *Spectra of η Argo. A.G.C.* 14626 *and A.G.C.* 14684. **W. M. W[orsell].** (Union Observat. of S. Africa, Circ. No. 46. p. 19, July 7, 1919.)—These were shown on one plate taken with the objective prism of the Franklin-Adams twin telescope, and measures of bright lines and bands in η Argo spectrum were made between H_α and H_β. Broad bands appeared at H_α, and at λλ 5271 and 5166. There is a broad band at H_α also in the other two stars on the plate. W. W. B.

1056. *Possible Rôle of Radiation-Pressure in Stellar Physics.* **F. Henroteau.** (Roy. Astron. Soc. Canada, J. 14. pp. 93–98, April, 1920.)—It is often plausibly assumed that no star has a mass greatly differing from that of the sun; possibly few greater than three times and none more than twenty times the sun's mass. But spectroscopic binaries indicate a mass function implying a mass many times smaller than that of the sun, though from other considerations they appear to be "giants." The author suggests that two bodies may have large actual masses, but small active masses in relation to each other, and that this difference may be the result of internal radiation-pressures. Taking Eddington's figures for masses of 10^n gm.; when $n < 34$ radiation-pressure is less than $\frac{1}{10}$ gravitation;

but when $n > 34$ the ratio is between $\frac{8}{15}$ and unity. Hence it appears that for stability 10^{34} is the only possible value, or within limits between 10^{33} and 10^{35}, which is the order of known masses. For greater masses radiation-pressure will break up the star and for smaller masses the energy will be too small for incandescence and conseqnent visibility. The author considers the possible value of the attractions due to gravitation, and the repulsion due to radiation-pressure, and finds that they may be of the same order of magnitude. He considers also the regular secondary oscillations in some Cepheid variables, and the oscillations of very short early B-type spectroscopic binaries, which appear to be combinations of two oscillations of slightly different lengths. He considers that in both these cases one of the oscillations can be well explained as an orbital motion due to radiation-pressure and not to gravitation. W. W. B.

1057. *Spectrum of Nova Geminorum II.* **1912.** **F. J. M. Stratton.** (Roy. Astron. Soc., M.N. 80. pp. 540–543, March, 1920.)—The work outlined previously [Abs. 714 (1919)] is complete and will be published in the Annals of the Solar Physics Observatory. The series of plates goes from 1912 March 15 to 1913 March 12, and includes plates taken at Cambridge and Allegheny. The chief changes are briefly summarised. The spectrum on the day after discovery, obtained at Michigan, was an absorption spectrum consisting of H, enhanced Ca, Fe, Ti, and Si, displaced to the violet (type A5). The absorption spectrum became intermediate in type between α Cygni and γ Cygni, and the displacement after a slight increase steadily diminished. A second set of α-Cygni absorption lines appeared on March 16, more displaced than the first, and slowly moved in the direction of their normal positions. On March 19 a third absorption still more displaced appeared, at first only showing H and He, but N and O being also found equally displaced. By March 25 there were two well-defined absorption spectra of different types, A-type (H, Fe, Ti, He, Ca), displaced by an amount corresponding to a velocity of approach of 800 km/sec., and B-type (H, He, O, C, N) with a velocity of approach 1450 km/sec. The bright bands remained normal for some weeks, but on March 26 the broad bright band at $464\mu\mu$ came up and the spectrum became most complete by March 30. The B-type absorption spectrum had become much the stronger of the two and resembled γ Orionis. The oscillation in about 3-day periods set in, and as the star faded the absorption spectrum was replaced by a bright-band spectrum. As the Fe and Ti dropped out the chief nebular lines grew stronger; by April 23 H, He, and Nb provided nearly the whole spectrum. During the summer the nebular type became more pronounced, and in Dec. indications of the Wolf-Rayet stage appeared. Meanwhile narrow dark lines in the undisplaced positions of H and K (Ca) were visible all through the series, with some much weaker dark lines not yet identified in novæ, indicating a weak α-Cygni spectrum. The evolution from A to B to nebular Wolf-Rayet type has been found in several previous novæ, but the relations have not hitherto been so simple as in Nova Geminorum. Electric and magnetic fields have failed to explain the phenomena, and it appears that the displacements must be real, and that they may be due to streams of gas issuing from points in the surface of a rotating body. It is hoped that the work done on this star, though insufficient for a final theory of evolution of novæ, will be of great value towards the interpretation of the much more complex phenomena of Nova Aquilæ. W. W. B.

1058. *Nature of Short-period Variables.* **H. C. Plummer.** (Roy. Astron. Soc., M.N. 80. pp. 496–518, March, 1920.)—Radial velocity in spectroscopic binaries, especially of short period, does not always follow simple elliptic motion. The character of the lines is not likely to give decisive evidence against pulsation theory. Perrine is mistaken in claiming that free oscillations would entail mean velocity of approach to the sun. The mean galactic latitude of all stars to 11th magnitude is about 25°, and half of them are within 19° of the galactic plane. The concentration of short period variables towards this plane is much higher. Correlations among orbit elements will not decide for or against pulsation. Superficial phenomena will not give a real test, but dynamical theory is unfavourable to hypothesis of free oscillations. The binary hypothesis must be reconsidered: Hagen's form evades some of the difficulties, but some of his suggestions are unacceptable. Short periods impose a lesser limit on the density of the primary. The limiting density required by orbital conditions will generally secure rotational stability of the primary. If short-period variables are large, the sharp lines in their spectra negative rapid rotation. They may therefore not be in rotational equilibrium, and thus may differ constitutionally from eclipsing binaries, in which tidal action checks tendency to more rapid rotation, but increases orbital elements to some extent, though not much unless masses are very unequal. Most pairs are of similar type and probably common origin. Few M stars are found among them. In short-period variables, on the other hand, tidal action increases rotation of primary and diminishes orbital elements until rotation and revolution are equalised. The long-period variables remain uncertain of classification, though their small proper motion is suggestive of great distance. If all red stars are variable the dwarf may be irregular, the more regular stars being giants (Md for instance). The spherical distribution of long-period variables is quite different from that of short-period variables. Phillips' Group I stars have periods ranging round 275 days, and his Group II round 350 days, the former being classed Md 3–6 and the latter Md 6–9. Phillips' stars, however, show the effect of selection, so the concentration of long-period stars towards the galaxy is not so strongly marked as it is claimed to be: the distribution of the two sets of variables (long and short) negatives direct connection by way of evolution. W. W. B.

1059. *Suggested Increase in Period of Variables of Phillips' Group I.* **H. H. Turner.** (Roy. Astron. Soc., M.N. 80. pp. 481–495, March, 1920.)—A number of stars of this class, including U Virginis, S Cephei, R Persei, etc., showed evidence of secular change of period. They are examined in the same way as those of the Group II stars which had diminishing periods. Of 14 stars in the paper, five, including U Virginis, show oscillation of period, with secular increase; four, including S Cephei, show one definite increase, generally large. R Persei shows steady increase, but is not well observed. The others are somewhat doubtful. Two of the stars are not yet assigned to Group I or II. One of them, η Geminorum, may have a double period like W Cygni. W. W. B.

LIGHT.

1060. *Nephelometer.* **C. Chéneveau and R. Audubert.** (Comptes Rendus, 170. pp. 728–731, March 22, 1920.)—On the basis of the formula previously given [Abs. 874, 875 (1919)] a simple nephelometer has been devised, the absorption of the turbid medium being compensated by that of a very acute angled glass prism of neutral tint. If *x* is the displacement of the prism corresponding with the compensation for a certain mean thickness *y* of the glass, *x* is a linear function of the total mass M of the particles in suspension in the medium. The instrument has an accuracy of from 2 to 5%, and is capable of numerous scientific and industrial applications, such as the formation of precipitates, velocities of reaction, determination of substances by precipitation, investigation of bacterial or colloidal emulsions, photographic plates, etc. T. H. P.

1061. *Optical Parts of 72-inch Telescope.* **J. S. Plaskett.** (Roy. Astron. Soc., Canada, J. 14. pp. 177–199, June, 1920.)—The author describes in detail the grinding and figuring of the great mirror, and the application of the Foucault "knife-edge" test, with Brashear's device of concentric slots to test the radius of curvature of different zones of the paraboloid, and the Hartmann method of extra-focal exposures. The zonal aberrations found are tabulated, none so great as ¼ mm., so that since changing temperature and atmospheric conditions produce changes much greater than this, the mirror may be considered practically perfect. The Hartmann test was employed to determine the change due to temperature, and an insulating cover of cotton felt was devised to protect the mirror from the effect of the higher day temperatures. This method has been found satisfactory, the performance of the mirror much improved, and the residual aberration negligible. The effects are shown graphically. The Cassegrain mirror tests are equally important, and have been also satisfactory, and the conclusion is confirmed that the residual errors present under constant-temperature conditions are entirely insignificant. W. W. B.

1062. *On Tracing Rays through an Optical System.* III. **T. Smith.** (Phys. Soc., Proc. 32. pp. 252–260; Disc., 261–264, June, 1920.)—Equations for tracing rays in an axial plane through an optical system have the normal refraction terms separated from those representing aberrations. By expressing the latter as a fraction with the first-order aberration as the numerator and a correcting factor, which may take various forms, as the denominator, rays may be traced exactly through the system using a short table of cosines in terms of sines in place of the extensive tables, giving sines in terms of angles generally employed. A considerable saving of time is effected in the calculations, and the estimation, without calculation, of the aberrations of other rays is facilitated. AUTHOR.

1063. *Optimum Magnification of a Telescope.* **Battestini.** (Comptes Rendus, 170. pp. 1167–1170, May 17, 1920.)—Considers the different effects of magnification on the visibility of an object viewed through a telescope when the luminosity is very low. The magnification should be capable of a reduction proportional to the square root of the brightness for constant visual acuity. Since it is useless to increase the size of the aperture above that determined by the maximum pupil of the eye, there is an illumination above which it is of advantage to maintain a constant magnification. As a result it is necessary to have different magnifications for day and night work, and in practice an intermediate power is also desirable. J. W. T. W.

1064. *Refraction and Dispersion of Carbon Dioxide, Carbon Monoxide, and Methane.* **C. Cuthbertson** and **M. Cuthbertson.** (Roy. Soc., Proc. 97. pp. 152–159, April 15, 1920.)—The refractions of these three gases have been measured for the green mercury line ($\lambda = 5461$) by means of a Jamin refractometer. The mean values of $(\mu - 1)10^7$, reduced to 0° and 76 cm., are as follows: Carbon dioxide, 4505; carbon monoxide, 3364; methane, 4415. The dispersions of the three gases are also given. The refractions and dispersions of the carbon atom, calculated from the results obtained on the assumption that refractivity is an atomic property which is nearly constant, vary widely, the additive law breaking down completely. Similar disagreement exists between the different values obtained for the number of dispersion electrons present and for the square of their free frequency. Evidently the forces controlling the motion of a dispersion electron in an atom are greatly influenced by the proximity of another atom in combination with the first. T. H. P.

1065. *"Raydex" Process of Photography in Colours.* **F. R. Newens.** (Phot. J. 59. pp. 238–241, Dec., 1919.)—A demonstration of the Raydex process. The process depends upon the hardening of gelatine by contact with the silver of a bromide print. Three bromide prints are prepared and brought into contact with sensitised carbon tissue in three colours; transfers are then taken in superposition. A. D.

1066. *Behaviour of Photographic Plates exposed to X-Rays.* **O. Block** and **F. F. Renwick.** (Faraday Soc., Trans. 15. pp. 40–46, Feb., 1920.)—A brief account of research on the action of X-rays upon gelatine dry-plates. Description of working methods is omitted, only the data necessary for understanding results being given. Curves in which "densities" ($\log_{10} O = 0$) are plotted against logs. of the times of exposure to a constant radiation closely resemble the well-known "characteristic curves" representing the action of light on photographic plates, but differ by having a more pronounced "foot," or strongly curved lower portion, than is found in the curves characteristic of light action. Moreover, within this lower range of exposures, densities are not proportional to the exposures received, as is the case with light in the so-called "period of under-exposure." No satisfactory formula, which is independent of time of development, has yet been evolved for expressing the sensitiveness of a plate to X-rays, and therefore at present no scientific criterion of X-ray plate speed exists. Mere variations in the length of time of development do not alter the general form, but only the steepness of the characteristic curve to X-rays; the growth of each individual density by prolongation of development conforms to the rule which holds for light-affected plates. The differences in gradation resulting from variations in the penetrating power of the radiation acting on the plate are small in comparison with those dependent on length of exposure and conditions of development. The effect of the intensifying screen on the gradation of the negatives varies with the qualities of the photographic plate employed. The interesting point is noted that silver bromide itself is feebly fluorescent to X-rays, but there does not appear to be any relation between the intensity of the fluorescence and its X-ray sensitiveness. At present there seems to be little prospect of making ordinary silver bromide dry-plates much more sensitive to X-rays than those now available. Some of the existing X-ray plates contain other substances which are either fluorescent or assist by reason of the secondary X-radiation they emit when acted on by very penetrating X-rays. Hitherto, however, no striking success along either of these lines has been achieved, most of the materials that have been found to enhance the X-ray effect being either injurious to the silver bromide emulsions, or too difficult to incorporate with it. The following are illustrated by graphs: (*a*) The relations between the masses of silver reduced by subsequent development and the quantities of radiation received by the plate; (*b*) Influence which developing agent can exert upon result; (*c*) Influence of wavelength of radiation on its penetrating power and on the steepness of gradation of resulting negative; (*d*) Effects of using the commercial calcium-tungstate screens in contact with a plate when exposing it to geometrically increasing doses of a constant quality of radiation; (*e*) Results of radiating various thicknesses of steel with and without an intensifying screen. A. E. G.

1067. *Isocyanine Dyestuffs.* **W. H. Mills** and **W. J. Pope.** (Phot. J. 60. pp. 183–198; Disc., 198–202, May, 1920.)—The preparation and properties of a number of members of the isocyanine dyes, among them pinaverdol or sensitol green are described, together with their colour-sensitising effect on photographic plates. T. H. P.

1068. *Colour Match and Spectral Distribution.* **E. P. Hyde** and **W. E. Forsythe.** (Frank. Inst., J. 189. pp. 663–664, May, 1920.)—When two different radiators, such as a tungsten and a carbon lamp, are colour-matched they may still differ somewhat in their distribution of energy in the visible spectrum. Using an optical pyrometer first with a red and then with a blue glass before the eyepiece, four different radiators—a black body, tungsten, tantalum, and untreated carbon—were set at the same relative intensity in the red and blue parts of the spectrum for several different temperatures. Measurements were then made with a green screen, and it was found that if these four radiators were colour-matched by determining the temperature for which the ratio of the red to the blue was the same, then the ratio of the red to the green was not quite the same as it should be if they had the same spectral distribution. The untreated carbon and the black body were sensibly the same; the ratio of red to green for tungsten differed from that of a black body by 0·5% at about 1500° K. to about 8% at 2900° K. The difference was about 6% throughout in the case of tantalum. J. W. T. W.

1069. *Propagation of Light in a Gravitational Field.* **A. O. Rankine** and **L. Silberstein.** (Phil. Mag. 39. pp. 586–591, May, 1920.)—The paper describes an investigation of the question whether the velocity of light in a gravitational field, such as that of the earth, is independent of the orientation of the light waves; whether, *e.g.*, the speed c_h of horizontal waves differs appreciably from the speed c_v of vertical waves. It is shown mathematically that, according to Einstein's theory, the speed of propagation, in the most general gravitational field, is a function of the vector representing the wave normal, but entirely independent of the orientation of the light vector. No theory other than Einstein's contemplates any connection between light propagation and gravity, but the authors considered it of interest to investigate the question experimentally. Let light rectilinearly polarised at 45° to the vertical be projected to an observing station on the same level at distance L. Then the phase difference ϵ of the vertical and horizontal components at the latter will be given by $\epsilon T = L(1/c_h - 1/c_v) \doteqdot L(c_v - c_h)/\lambda c$, where T is the period of the light, $\lambda = cT$ is the normal wave-length and c_v and c_h differ but little from c. If, then, $c_v \doteqdot c_h$, the light will be elliptically polarised, the ellipticity κ being given by

$$\kappa = (1 - \cos 2\pi\epsilon)^{\frac{1}{2}}/(1 + \cos 2\pi\epsilon)^{\frac{1}{2}} \doteqdot \pi\epsilon,$$

if the angle $2\pi\epsilon$ be small. Hence $c_v - c_h \doteqdot c\kappa\lambda/\pi L$. No ellipticity was observable in experiments made to test this, although their delicacy was shown by control measurement to be such that the small result involved the conclusion that $(c_v - c_h)/c < 8 \times 10^{-13}$. G. W. de T.

1070. *Elementary Theory of Light Scattering by Small Dielectric Spheres.* **J. Kunz.** (Phil. Mag. 39. pp. 416–422, April, 1920.)—This is a solution by elementary mathematical methods of a problem solved by Rayleigh [Sci. Papers, 1. p. 87; 4, p. 397]. G. W. de T.

1071. *Atomic Vibrations and Molecular Spectra.* **T. Heurlinger.** (Zeits. f. Physik, 1. 1. pp. 82–91, 1920.)—According to Bohr's theory the atom nuclei in a molecule can give rise to oscillations which obey the quanta laws. If the nuclei are related in a quasi-elastic manner to the equilibrium positions, then the energy values for a diatomic non-rotating molecule are the same as for a Planck oscillator, namely: $E = nhw$, where n denotes the quantum number for the atomic oscillation, h the Planck constant, and w the oscillation number. If n and n' are two states, then light of oscillation frequency $\nu = (n - n')\omega$, will be emitted or absorbed in transition from one to the other (for a hetero-polar molecule). According to Bohr's analogy principle, only the transitions $n - n' = \pm 1$ occur, so that only the line $\nu = \omega$ is to be expected. In consequence of molecular rotation a line-resolvable double band occurs instead of this simple line, and for the case of diatomic gases has been identified with the strong double band observed in the ultra-red. When the nuclei are not exactly related in a quasi-elastic manner, the transitions $n - n' = 2, 3 \ldots$ are not entirely excluded, and double bands are to be expected whose centres possess the oscillation frequencies 2ω, $3\omega \ldots$. Such feeble bands due to these deviations have been observed by Brinsmade and Kemble (Nat. Acad. Sci., Proc. 3. p. 420, 1918), and investigations on the hydrogen molecule indicate further deviations which cannot be neglected. This analogy principle is used in the present paper for the elucidation of the structure of the ultra-red double bands and the rotation spectra. The latter are found to consist of a series of groups of lines, and not of a series of simple lines. In a system of Deslandres' bands, lines may be determined which are explained theoretically as the spectrum of the non-rotating molecule. The two whole numbers, n and p, on which the oscillation frequencies of these lines depend, are explained, at least for one type of band spectrum, as two values of the quantum number which determines the atomic oscillation. The combination principle, whose validity for the above oscillation numbers has been established in an earlier communication, is now supported by further examples. It is then shown how the absolute values of n and p may be determined and used for the calculation of the oscillation numbers, which, according to theory, form the spectrum of the non-rotating and non-oscillating molecule. H. H. Ho.

1072. *Theory of Rotation Spectra.* **F. Reiche.** (Zeits. f. Physik, 1. 4. pp. 283–293, 1920.)—The results described in the present paper were completed simultaneously with the appearance of a communication on similar lines by Lenz [see Abs. 574 (1920)]. The absorption and emission bands of polyatomic gaseous compounds in the long-wave ultra-red part of the spectrum are usually ascribed to the rotation of the gaseous molecules, the atoms of which carry polar electrical charges. According to the classical electrodynamic theory radiation is emitted and absorbed by virtue of this molecular rotation. The quantum application of Planck to this problem is quoted [see Abs. 952 (1917)]. The author finds that the HCl molecule possesses no rotary impulse or at the most a monoquantic one about its long axis (the line joining the nuclei), and this applies to all diatomic heteropolar gas compounds. This is contrary to the Bohr and Kossel model, with its rotating electronic ring, which demands a polyquantic rotary impulse for the system. This result would favour a model similar to that proposed by Haber and Borns. Before the proofs of this paper were corrected, however, the results of some very accurate observations by Imes on the halogen hydrides appeared, which were not in exact accord with the deductions of the paper. The author concluded, therefore, that some of his premises were invalid, but a modification in the rotation quantelation suggested by Einstein has enabled agreement with Imes' observations to be attained. H. H. Ho.

1073. *Regularities in the Ultra-red Gas Spectra and their Interpretation.* **G. Hettner.** (Zeits. f. Physik, 1. 4. pp. 345–354, 1920.)—With the exception of the chemical elements, gases possess one or more absorption bands in the region between the visible spectrum and a wave-length of about $20\,\mu$. These bands are regarded as due to a periodic change of the electrical moment of the molecules in consequence of the oscillations of the atoms. If the amplitude of the oscillations be assumed to be small compared with the distance apart of the atoms, the forces can be regarded as quasi-elastic, in which case pure sine oscillations obtain. According to the classical theory, the frequency of the absorbed waves is identical with the frequency of the oscillations, so that the max. number of absorption bands will be the number of special frequencies of the molecules. The latter, in the case of infinitesimal oscillations, is equal to the number of internal degrees of freedom of the molecule, *i.e.*, equal to the total number of degrees of freedom, less those of translation and rotation; *e.g.*, with monatomic molecules zero, with diatomic 1, with n-atomic ($n>2$) equal to $3n-6$. With certain gases, however, the number of bands is greater than the number of internal degrees of freedom, HCl and HBr possessing 2, and H_2O at least 8 bands. With diatomic gases the weaker band appears to be almost exactly the octave of the stronger, and this may only be explained by a deviation from the quasi-elastic force law.

The author now investigates the effects produced in the general case of several degrees of freedom, of introducing special forces between the atoms. The considerations advanced do not take into account the rotation of the molecule. A large number of sine oscillations are superposed, and the relations arising between the frequencies are compared with experimental results. These considerations, based on classical mechanics and electrodynamics, are valid also for Planck's second quantum theory, although the Bohr theory makes special treatment necessary, for which purpose Tank's results are available. A table of results is included for HCl, HBr, CO, HCN, C_2H_2, H_2O, CH_4, C_2H_4, and $(CH_3)_2O$, and shows good agreement between theory and observation. The apparently irregular bands for water-vapour in the red and ultra-red are explained as far as the commencement of the rotational region.

H. H. Ho.

1074. *Furnace Spectra in the Infra-Red.* **A. S. King.** (Mt. Wilson Observat., Contrib. No. 181. Astrophys. J. 51. pp. 179–186, April, 1920). —The results presented in this paper were obtained during a series of experiments designed to extend as far as possible into the infra-red several furnace spectra which have previously been studied in the region λ 3000 to λ 7000 [Abs. 1158 (1918)]. Using plates sensitised with dicyanin, a study was made of the infra-red spectra of Co, Ni, Ba, Sr, and Ca for three different temperatures of the electric furnace. The lines of the arc spectrum, above a certain minimum intensity, appear for the most part in the furnace spectra. Some strong arc lines, however, were not obtained in the furnace, and, on the other hand, a number of examples appear of lines strong in the furnace which are faint in the arc. Besides these features, the same variety as to rate of increase of line intensity with temperature was observed as for the visible spectrum, and the resulting classification is based on the differing response to varying temperature.

A. W.

1075. *Formation of the Band Spectrum of Iodine and its Position according to the Quantum Theory.* **W. Steubing.** (Zeits. f. Physik, 1. 5. pp. 426–430, 1920.)—During the course of some work [see Abs. 596 (1919)], which concerned the band spectrum of iodine excited by fluorescence and by electrical means, a series of observations were made on the nature and behaviour of its carriers, and these form the basis of the present paper. These experimental results are as follows: (1) The fluorescent band spectrum of iodine produced by white light is spectrally identical with that produced by electrical means, such as the kathode rays. (2) In all cases the carrier of the spectrum is non-electrical, *i.e.*, the band spectrum is not to be ascribed to an ionised atom or molecule, but arises when the ionised atoms are neutralised and reunite to the molecule. It follows as a consequence that in the latter process the energy evolved as an emission is equal to that required for the dissociation and ionisation of a neutral molecule. The same theoretical procedure is adopted towards the emission process of the molecular band spectrum, as for the calculation of series lines according to the Bohr atomic model. By means of the quantum theory a short-wave limiting position of the band spectrum is calculated, which corresponds satisfactorily with the actual facts. When these considerations are applied to the other halogens, so far as spectral evidence obtains, a good agreement is found with Bohr's data for thermal analysis, showing a connection between the latter and the band spectrum. H. H. Ho.

1076. *Spectrum of Copper.* **W. M. Hicks.** (Phil. Mag. 39. pp. 457–481, May, 1920.)—Continuing his systematic investigation of spectra the author in the present paper applies similar methods to the discussion of the copper spectrum as have already been successful in dealing with those of silver and gold [Abs. 1507 (1919)]. The arc spectrum of copper differs from those of the other metals of the group in that it is very rich in lines. It is, however, similar to them in general plan, and the similar conclusions arrived at in each receive greater support in combination. Strong well-defined sets are given for the orders $m = 2, 3$ in both the S and D sets, and for the first order of P. Those for S (2) are in the red, and in step with those for silver. The others show the Zeeman patterns proper for their respective types. These may therefore be adopted definitely as normal series lines. For the higher orders, however, the intensities fall off more quickly and irregularly than usual, and there is also evidence for numerous displacements. In fact, these are apparently the cause of the low intensities and the large number of weak lines. In consequence the determination of the S and D limits with any exactness from the series lines alone is rendered impossible. A. W.

1077. *The Absorption of X-rays.* **R. A. Houstoun.** (Roy. Soc. Edinburgh, Proc. 40. 1. pp. 34–42, 1919–1920.)—The author derives the ordinary expression used to represent the variation of the coefficient of absorption through an absorption band in the case of ordinary light-waves. The method of deriving it differs from the conventional method which requires that there should be many electrons to the wave-length, and consequently is not suitable for wave-lengths as short as those of X-rays. The proof given is free from this restriction. The expression obtained is applied to absorption bands in X-ray spectra, and the following rule is deduced: If $\mu\lambda$ be graphed as a function of $1/\lambda$, and the area of the absorption band measured, then the number of electrons per unit volume concerned in its production is $(mc^2)/(\lambda_m \pi e^2)$ times the area of the band, where λ_m is the wave-length of the maximum of the band, μ the absorption coefficient, and c the velocity of light. Employing the experimental data available, it was found that the K absorption bands of different atoms or molecules are due in each case to the vibration of one electron per atom or per molecule. The remainder of the paper deals with certain criticisms which might be made regarding this result. E. A. O.

1078. *Note on the Scattering of X-rays.* **R. A. Houstoun.** (Roy. Soc. Edinburgh, Proc. 40. 1. pp. 43–50, 1919–1920.)—Whilst Thomson's theory explains the main features of the phenomenon of the scattering of X-rays by matter, there are certain facts for which it affords no explanation. These are (1) the increase of scattering with heavy elements for soft rays, (2) the extra-radiation, and (3) the low value of the scattering coefficient of γ-rays. The present paper is an attempt to extend the theory to cover these facts also. Working on Barkla's suggestion that (1) is to be explained by interference between the different electrons in the atom, the atom scattering as a whole in the case of the longer wave-lengths, the author arrives at a general expression for the energy scattered in any direction. If the wave-length is very long then, according to this expression, the energy radiated is n^2 times greater than that given by the original expression $[I = I_{\pi/2}(1 + \cos^2 \theta)]$ for the scattering by a single electron, and n times greater than that by the atom, a result anticipated by Barkla and Dunlop [Abs. 685 (1916)]. The expression also accounts for the experimental results of Owen on the asymmetry of X-rays [Abs. 1494 (1911)], but it fails to account for the low value of the scattering coefficient of γ-rays, although the theoretical curves given by it for the distribution of scattered radiation round a radiator are very similar to those found experimentally by Florance [Abs. 884 (1914)]. E. A. O.

1079. *Law of Mass-absorption of X-rays.* **F. Butavand.** (Ann. de Physique, 13. pp. 161–168, March–April, 1920.)—The author deduces empirical formulæ representing the absorption in Al of the characteristic X-radiations of a number of elements. An approximate empirical formula thus obtained is $(\lambda/\varrho)^{1/5} \times P = C_{(Al)}$, where P is the atomic weight and λ/ϱ the absorption coefficient, C being a constant having a value which is about 135 for Al (K series) and about 400 for Al (L series). A. B. W.

1080. *Properties of Intensifying Screens in regard to X-ray Spectra; Doubling of the β-line of the K-spectrum of Tungsten.* **M. de Broglie.** (Comptes Rendus, 170. pp. 1053–1056, May 3, 1920.)—Intensifying screens employed in radiography act through the agency of two groups of rays emitted under the influence of the X-rays falling on the screen. The first group of rays is the secondary radiation excited in the active layer of the screen; this is an *atomic* phenomenon, which only depends on the elements present in the screen, and not on their physical or chemical state. The second group of rays comprises the luminous radiations which make radioscopy possible, and which act on the photographic plate, by reason of the proportion of violet or blue light which is present; this phenomenon, as in the general case of phosphorescence, is dependent on a variety of factors, chemical and crystalline state, and also impurities playing an important part; it is not entirely an atomic phenomenon. Both groups contribute to the intensifying power of a screen, but the effect of the second group is, generally speaking, the more important. The author now describes an investigation in which the effects of the two groups of rays are analysed—by employing screens of different kinds (*e.g.*, metal screens giving secondary rays, but no fluorescence, etc.). The effect of varying the wave-length of the secondary radiation (using screens of different elements) is considered. He has found that the luminous excitation of the screen is dependent on the absorption band of the heavy metal (tungsten, platinum, etc.), which the screen may contain. By using metals of widely different atomic weight this effect has been exaggerated to a marked degree. A. B. W.

HEAT.

1081. *Thermal Conductivity and Viscosity of Gases.* **J. A. Pollock.** (Roy. Soc. N.S. Wales, J. and Proc. 53. pp. 116–119, Dec., 1919.)—Hercus and Laby have recently redetermined the thermal conductivity of air. [Abs. 455 (1919)]. Combining their result with those of 11 other experimenters, they give $k = 5\cdot22 \times 10^{-5}$ as the most probable value of the conductivity at 0° C. This result enables Eucken's conductivity measurements of a number of gases relative to that of air, to be put on a more accurate basis. After reviewing the whole evidence, Hercus and Laby have collected for the various gases the most probable values of the following constants :—k, the thermal conductivity, C_p the specific heat at constant pressure, γ the ratio of the specific heats, and η the viscosity. With these results they have calculated the values of f given by the equation $f = \gamma k_o/\eta_o C_p$. As the value of f depends on the atomicity of the molecule, attempts have been made to find a relation between f and γ. Jeans has suggested the formula, $f = (9\gamma - 5)/4$, which agrees well with Eucken's original results, but is no longer accurate when the conductivity of air is taken as $5\cdot22 \times 10^{-5}$ instead of $5\cdot66 \times 10^{-5}$. Hercus and Laby suggest, on empirical grounds, another linear form, $f = 2\cdot816\,\gamma - 2\cdot2$. The author has previously proposed the equation $f = a(\nu - 1)/\gamma$, where a is a constant, for Eucken's original numbers [see Abs. 340 and 1251 (1916)], and now shows that $f = 6\cdot15\,(\nu - 1)/\gamma$ is appropriate for the new values. Tables of data are given. This formula indicates that for perfect gases the following simple approximate relation exists between the conductivity and viscosity, namely : $m\gamma k_o\eta_o = 2a$, where m is the molecular mass and a the constant in the above equation. H. H. Ho.

1082. *On the Forces acting on Heated Metal-Foil Surfaces in Rarefied Gases.* **G. D. West.** (Phys. Soc., Proc. 32. pp. 166–189; Disc., 189, April, 1920.)—An experimental investigation of the nature of certain peculiar movements of strips of thin metal foil surrounded by rarefied gases, and exposed to radiation. The experiments deal chiefly with phenomena at gas pressures below 1 cm. of mercury, and it is shown that the apparently diverse results obtained can be connected by a theory based on the work of a previous communication [Abs. 1519 (1919)]. It is concluded that, at the highest rarefactions, the pressures on the strips arise from the fact that, if differences of temperature exist in an enclosure, the pressure of the gas is not uniform, but varies approximately as the square root of the latter's absolute temperature. The simple conditions that exist at low gas pressures are complicated, at the higher pressures, by gas currents which differ fundamentally from convection currents, but which are closely connected with the phenomena of thermal transpiration. AUTHOR.

1083 *A Modified Theory of the Crookes Radiometer.* **G. D. West.** (Phys. Soc., Proc. 32. pp. 222–231, June, 1920.)

1084. *Combustibility of Mixtures of Hydrogen and Helium.* **J. Satterly** and **E. F. Burton.** (Roy. Soc. Canada, Trans. 13. Sect. 3. pp. 211–215, 1919.)—On behalf of the British Admiralty it was investigated to what extent the helium (from natural gas) for balloon charges could be diluted with hydrogen. The mixtures were expelled through a Travers siphon, a glowing Pt spiral being held just above the jet; the gas would not burn when less than 26% of hydrogen was present. This was more or less confirmed by other experiments. Mixtures of helium, hydrogen, and air sparked in eudiometer tubes did not give decisive results. The ignition of soap bubbles charged with the mixture was abandoned as too much helium was then wasted. Other experiments were made with small rubber balloons, blown up with the gas mixture to diameters of about 2½ in. and ignited by approaching a glowing Pt spiral or a lighted match to the fabric, which did not itself burn. H. B.

1085. *Characteristic Equation appropriate to Air.* **E. Fouché.** (Comptes Rendus, 169. pp. 1089–1092, Dec. 8, 1919.)—Experiments on air at low temperatures are too few to solve all the problems which arise in practical applications at such temperatures. The author proposes to utilise the results of experiments by Witkowski over a range 1 to 130 atmos. and − 145° to + 100°, and to deduce from the laws of thermodynamics all the coefficients of practical use. In the present paper is established the characteristic equation $[p + \phi/(v + n)^2]\ (v - b) = \mathrm{R\,T}$, where n and b are constants and ϕ a function of T only. Expressing p in kg/m.^{3} and v as the volume of 1 kg. of fluid, then $b = 0{\cdot}000850$; $n = 0{\cdot}000350$; $\mathrm{R} = 29{\cdot}3$; $\phi = \beta - a\log_{10}\mathrm{T}$, $(a = 18{\cdot}662;\ \beta = 55{\cdot}914)$. This equation gives isothermal lines corresponding well with those of air. The fictitious gas exactly obeying the equation the author calls "aëroid."

M. A. G.

1086. *Characteristic Equation appropriate to Air.* **E. Fouché.** (Comptes Rendus, 169. pp. 1158–1160, Dec. 15, 1919.)—A characteristic equation applicable to air has already been established by the author [see preceding Abs.]. In the present paper is given a selection of the properties of "aëroid," the fictitious gas exactly obeying the characteristic equation, deduced from thermodynamical theory. The critical point corresponds to temperature − 137°·23, pressure 40·1 atmos. and specific volume 0·00325 m.^{3}. Of vapour tensions, that of 1 atmo. is stated to correspond to a temperature of − 191°·75, which may be compared with the experimental figures for air, − 191°·5 to − 194°, due to Baly. Latent heat at 0·99 atmo. as calculated is 51·11 cals. and by experiment about 51 cals. At the critical temperature the following values are given for the specific heat (C) :—

Pressure in Atmospheres....	1	20	30	38	40·1	50	100	200
Value of C	0·239	0·329	0·488	1·346	∞	1·123	0·599	0·479

A large number of values of the integrals $\int_{\mathrm{T}_0}^{\mathrm{T}_1} \mathrm{C}\,dt$ and $\int_{\mathrm{T}_0}^{\mathrm{T}_1} \mathrm{C}/\mathrm{T}\,dt$ have been calculated but the results are not given. Two applications are made to the problem of liquefaction of air. M. A. G.

1087. *Change of Molecular Kinetic Energy into Molecular Potential Energy: Entropy Principle and Molecular Association.* **W. D. Harkins.**

(Nat. Acad. Sci., Proc. 5. pp. 539–546, Dec. 22, 1919.)—The author's work on the orientation of molecules in the surfaces of liquids has led to the recognition of a new principle, which may be stated in the following form: Whenever a molecule moves from the interior of a liquid into the surface in such a way as to form a new surface, the average amount of its kinetic energy which is converted into potential energy is equal to 144% of the mean translational kinetic energy of a gas molecule at the same temperature. The free energy of the surface is simply the difference between the total energy, which depends upon the structure of the surface, and the latent heat of the surface which is conditioned by the above law; this renders evident the reason for the decrease of the surface tension or of the free surface energy as the temperature falls.

In terms of entropy the author's principle is expressed thus: Whenever a molecule moves from the interior of a liquid into its surface in such a way as to form part of a new surface, the entropy of surface formation is independent, not only of the nature of the molecule, but also of the temperature. This entropy has the numerical value, $2{\cdot}96 \times 10^{-16}$ erg per degree per molecule, and is not the ordinary thermodynamic entropy, but is about 15% less than the thermodynamic entropy calculated for the area occupied by one molecule.

The Ramsay and Shields relation may also be expressed in terms of entropy as follows: The entropy of the surface of a liquid is 2·12 ergs per degree for an area equal to that of one face of a cube containing one gm.-molecule of the liquid. The author is not in agreement with the criticism that, since the Ramsay-Shields method of calculating the degree of molecular association is a surface tension method, it gives no true indication of the molecular state of the liquid as a whole. A second criticism made is that very complex molecules, especially those containing several paraffin chains, such as tripalmitin and tristearin, give excessively high values of the Ramsay-Shields constant; such values are, however, greatly reduced if the molecular orientation in the surface is taken into consideration.

Although the entropy principle itself has hitherto remained unrecognised, various empirical relations have been published which would involve the much more general entropy principle: When in a system consisting of one component, a molecule moves from one region into another, the average molecular kinetic energy which is converted into the form of molecular potential energy depends in general only on the change of state, that is, on the region from which the molecule comes and the one into which it goes, provided that when a vapour phase is involved one condition which enters is the state of the vapour with reference to one variable; the term region is used here to denote a phase, surface, or interface.

The "normal" values of the entropy have been calculated in accordance with the various empirical relations, and from a study of the available data in the entropy of melting certain general relations have been discovered. T. H. P.

ELECTRICITY AND MAGNETISM.

THEORY, ELECTROSTATICS, AND ATMOSPHERIC ELECTRICITY.

1088. *Difference between Magnetic and Electric Energies as Pressure.* **R. Hargreaves.** (Phil. Mag. 39. pp. 662–667, June, 1920.)—The subject of the paper is the theorem that for any electromagnetic field the pressure on a perfectly reflecting surface is normal, and is measured by the difference between the magnetic and electric energies per unit volume at the surface. It is suggested that this theorem should be viewed in conjunction with an analogous theorem of the author's in hydrodynamics [Phil. Mag. Sept., 1908], as the analogy may possibly be helpful in considering the nature of the kinetic potential in electromagnetics. The author considers first the application of the theorem to the simple problem of reflection of a plane wave at a fixed plane surface. He then deals with a moving plane surface, and finally considers a general electromagnetic field near the surface of any conductor in motion. G. W. DE T.

DISCHARGE AND OSCILLATIONS.

1089. *Ionisation Potentials of Argon, Nitrogen, Carbon Monoxide, Helium, Hydrogen, and Mercury and Iodine Vapours.* **C. G. Found.** (Phys. Rev. 16. pp. 41–53, July, 1920.)—The object of this investigation was the determination of the effect of the presence of gas on the volt-amp. characteristics of a two-electrode discharge tube, and the determination of the voltage at which various gases affected the space charge of the tube, that is, the ionisation potential of the gases. The method used was similar to that employed by Foote and Mohler, except that a commutator was used which broke the filament heating circuit while the space current was being measured. By this method the complication of a voltage drop along the filament was avoided, and the relation $i = A(V - V_0)^{3/2}$, where V_0 is the voltage equivalent of the initial velocity of the electrons, holds up to the voltage at which ionisation occurs. The ionisation potential of argon was found to be between 15 and 16 volts and was constant for pressures from 1 to 200 bars. With increase in filament temperature, the apparent ionisation potential was lowered, but when compensation was made for the initial velocity of the electrons, the real value was found to coincide with that obtained at lower filament temperature. The ionisation potential of nitrogen was found to be about 16 volts, while that of CO was about 13·5 or 14 volts. Ionisation commenced in mercury vapour between 10 and 11 volts. Helium and hydrogen were also studied. A value of 20·5 volts was obtained for helium, but the purity of the gas was questionable. Hydrogen gave a value of 15 volts; this value is unreliable, however, owing to the rapid absorption of hydrogen by the hot filament. The value obtained for iodine was 8·5 volts. A. W.

1090. *Critical Velocities for Electrons in Helium.* **F. Horton** and **[Miss] A. C. Davies.** (Phil. Mag. 39. pp. 592–603, May, 1920.)—Describes further work on helium [see Abs. 718 (1920)]. The experiments here dealt with confirm previous results of about 20·5 and 25·6 volts for the first two critical velocities for electrons in helium, and show also that there is a critical velocity at about 80 volts. The latter is presumably the velocity at which both electrons are removed from the atom at a single collision. This value should be the sum of the velocities required to remove the two electrons separately from the helium atom. A velocity of 25·6 volts is required to remove the first electron, so that about 54 volts is the velocity required to remove the second electron. This value agrees with that deduced from Bohr's theory. The results obtained are in agreement with those of Franck and Knipping [Abs. 251 (1920)], but differ from theirs in indicating bends in the current curves at 41 volts and 55 volts, which appear to be due to the production of radiation and of further ionisation, respectively, from the helium atoms which have already lost one electron. A. W.

1091. *Calculation of the Constants of the Triode Tube or Audion.* R. W. King. (Phys. Rev. 15. pp. 256–268, April, 1920.)—Given the characteristic equation of such a device as $I_p = \kappa(E_p/\mu + E_g)^\eta$, it is shown that the value of the amplification constant μ is practically independent of the density of the space charge. It therefore follows that μ can be calculated in accordance with well-known principles in electrostatics from the dimensions of the tube. The calculation of μ as well of κ is carried out for four classes of tube structures.

1. The structure with plane-parallel elements in which the filament is symmetrically placed between grids and plates;
2. The structure with cylindrical anode and grid and a coaxial strand of filament;
3. The structure with cylindrical anode and grid and several parallel strands of filament arranged on an internal coaxial cylinder;
4. The structure similar to Class 3 except that the strands of filament lie on an external coaxial cylinder. These calculations result in the following formulæ: *Class* 1.—Given α the distance from plate to grid, β the distance from grid to filament, n the number of grid wires per unit length, r the radius of the grid wires, and A the total plate area,

$$\mu = \frac{2\pi\alpha n}{\log_e \frac{1}{2\pi r n}}, \quad \kappa = 2\cdot 33 \times 10^{-6} \frac{A}{\sqrt{\alpha+\beta}} \left(\frac{\mu}{\alpha+\beta(\mu+1)}\right)^{3/2}.$$

In this and the following values for κ it has been assumed that the exponent η has the value 3/2. This assumption in general gives good numerical agreement. *Class* 2.—Given R_p, R_g, R_f, the radii of plate, grid, and filament respectively, and l the length of the structure,

$$\mu = \frac{2\pi R_g^2(1/R_g - 1/R_p)n}{\log_e \frac{1}{2\pi r n}},$$

$$\kappa = 14\cdot 65 \times 10^{-6} \frac{l R_p^{1/2} \mu^{3/2}}{[(R_p - R_g) + R_g(\mu + 1)]^{3/2}}.$$

Classes 3 *and* 4.—The expression for μ is that given under Class 2. The expression for κ is:

$$\kappa = 14\cdot 65 \times 10^{-6} \frac{l R_p \mu^{3/2}}{\sqrt{\pm(R_p - R_f)} \pm [(R_p - R_g) \pm (R_g - R_f)(\mu + 1)]^{3/2}},$$

where the signs are taken in such a way as to make all terms positive.

AUTHOR.

1092. *The Lichtenberg Figures.* **P. O. Pedersen.** (K. Danske Vidensk. Selskab. 1. No. 11. pp. 1–76, 1919.)—A paper in English, copiously illustrated, on Lichtenberg figures obtained by photographic means. The general features of the figures are discussed, and the velocity of the positive and negative Lichtenberg discharges is investigated. The preliminary hypothesis is discussed that the negative figures are due to electrons moving outwards from the electrode and causing ionisation along their path; this seems to agree with all the experimental facts. Probably the positive figures are also due to electrons moving outwards; but there are outstanding difficulties in this hypothesis which will form the subject of a later paper. The secondary figures seem due to ionisation in the air. The positive figures in gases other than air are illustrated; and measurements are given of the retardation caused by spark-gaps, down to 10^{-9} second. A. D.

1093. *Absorption of Gases in the Electric Discharge Tube.* **F. H. Newman.** (Phys. Soc., Proc. 32. pp. 190–194; Disc., 194–195, April, 1920.)—Describes a method of showing that absorption of nitrogen takes place in the discharge tube when sodium and potassium are used as the electrodes. The amount of gas absorbed for different quantities of electricity passing in the circuit is measured and is less than that absorbed by the Na-K alloy. It shows also that when the alloy is used the amount of gas absorbed increases with temperature. AUTHOR.

ELECTRICAL PROPERTIES AND INSTRUMENTS.

1094. *The Metallic Conductivity of Zinc Oxide.* **F. Skaupy.** (Zeits. f. Physik, 1. 3. pp. 259–260. 1920.)—The electrical conductivity of ZnO in the form of small pressed plates increases considerably when the current is passed for a few seconds, the specimen being *in vacuo*, or in an atmosphere of N or H. A McLeod gauge connected to the vacuum tube showed no sensible change of pressure during the passage of the current. On exposure to air the specimen slowly recovers its normal resistance. There is no essential difference between direct and alternating current. Only a very small part of this change is to be ascribed to a negative temperature coefficient of resistance. The possibility of various technical applications of this property of ZnO is suggested by the author. L. L.

ALTERNATING CURRENTS AND MAGNETISM.

1095. *Method of Testing Bars of Magnet Steel.* **N. W. McLachlan.** (Phys. Soc., Proc. 32. pp. 154–165, April, 1920.)—Tests on cylindrical bars of magnet steel 1 in. diam. and 10 in. long are described. The tests were conducted using a slight modification of Ewing's double permeameter method. Instead of employing pinching screws in the yokes, the bars and yokes were ground accurately to 1/1000 in., and arranged to make a good push fit. The method is compared with that in which use is made of differential coils for measuring the value of the magnetising force *in situ*, as developed at the National Physical Laboratory. It is shown that tests with the latter method can be conducted more speedily and accurately than with the double permeameter method. The variation in the magnetising force along the bar and the leakage between the pairs of bars in the permeameter are treated. A formula is developed, by means of which, with the aid of experimental data given in the paper, a correction can be applied to allow for leakage effects. A B-H curve and hysteresis loop are given for a certain sample of magnet steel; also the details of the permeameter. AUTHOR.

1096. *Characteristic Constants of Small Magnets.* **A. N. Shaw.** (Roy. Soc. Canada, Trans. Sect. 3. pp. 153–158, 1919.)—The paper originated in the determination of some small corrections in using the Weber type of electrodynamometer for absolute measurements [see Abs. 1324 (1914)]. It is shown that even in some null methods the effect of the characteristic magnetometer constants may have to be considered, and that they may be determined in a comparatively simple manner with the aid of standard coils. In the usual symmetrical instruments the axes of the fixed and moving systems intersect, and the difficulty in the determination of the mutual potential energy arises from the space included between the two systems and straight lines joining their boundaries. By expressing the solid angles involved in terms of zonal harmonics a very convenient method of defining and determining the constants of the magnetic system is developed. The method of procedure is outlined and examples are given of common formulæ corrected by the inclusion of these constants. G. W. DE T.

1097. *Magnetisation and Hysteresis in Hæmatite Crystals.* **T. T. Smith.** (Phys. Rev. 15. pp. 345–364, May, 1920.)—*Magnetisation and Hysteresis in Hæmatite Crystals; Experimental Procedure.*—In a previous paper, the author has given the results of an investigation of the magnetic properties of crystallised hæmatite, the measurements being of the force exerted upon a sphere when it is placed in a non-uniform magnetic field. The present paper contains some results obtained by measuring the couple exerted when a hæmatite sphere is suspended in a uniform magnetic field. The couple in a uniform field measures the component of magnetisation perpendicular to the field; the force measures the component parallel to the field.

Experimental Data.—The paper contains (1) *magnetisation curves* for two specimens of hæmatite; (2) *hysteresis loops* at fields from 9·5 to 1020 gauss, some obtained with a rotating field, the others with an alternating field; (3) a graph representing *components of magnetisation* parallel and perpendicular to the field.

Deduction.—*The normal magnetisation curve* of the hæmatite consists of a sharp rise followed by a slow increase, which is proportional to the field strength. The *hysteresis energy loss* increases with an increase in the maximum field applied up to a certain field, and thereafter the area of the hysteresis loop remains constant. For the specimen on which most of the present measurements were made, the hysteresis loss is constant for field strengths above about 150 gauss. AUTHOR.

1098. *Magnetic Properties of Silicon Iron (Stalloy) in Alternating Magnetic Fields of Low Value.* **A. Campbell.** (Phys. Soc., Proc. 32. pp. 232–242; Disc., 242–243, June, 1920.)—Measurements are described of the hysteresis losses in silicon iron sheet and wires in very low alternating magnetic fields at low and telephonic frequencies using an alternating current method previously described [Abs. 1034B (1909)]. The equations giving the hysteresis losses as a function of $B_{max.}$ are deduced in the case of the sheet material at low frequencies for ranges of $H_{max.}$ from 0·0002 to 0·02.

Comparisons are made between sheet material and wires of different diameters, and curves are given showing the great improvement in the permeability of wires when they are annealed.

The behaviour of the material is studied, both by ballistic tests and at telephonic frequencies, as regards the alternating field when direct-current fields of various values are applied at the same time.

AUTHOR.

1099. *Neutral Magnetisation in Iron.* **A. W. Smith and H. E. Hammond.** (Phys. Rev. 15. pp. 249–255, April, 1920.)—*Neutral Magnetisation in Iron; Unsymmetrical Hysteresis Curves through the Zero Point; Comparison with the Normal Magnetisation Curve.*—Precise experimental measurements of unsymmetrical hysteresis loops passing through the zero point are given for rings of Swedish iron, cast iron, and cast steel. Some writers have claimed that such a curve, after passing through the zero point, follows the normal magnetisation curve. It is now shown that it does not follow the magnetisation curve, but has a steeper slope at the zero point and for some distance beyond, this slope depending upon the degree of magnetisation at the tips of the corresponding hysteresis curve. Since the condition of the iron represented by the zero point on such a loop is not that of demagnetised iron, the authors call it *neutral magnetisation.*

Normal Magnetisation Curves: Method of Reversals and the Step-by-step Method.—The normal magnetisation curves are also determined for these rings, both by the *method of reversals* and by the *step-by-step method.* Each method gives the same curve as nearly as can be shown in the figures.

Demagnetisation of Iron; Allowable Frequency of Reversals; Eddy Currents.—These curves can be re-determined at any time, *provided* that the iron is first thoroughly *demagnetised.* This requires a sufficient interval of time between successive reversals of the magnetomotive force to allow the *eddy currents* in the iron to fall to zero. A special form of reversing rheostat is used to eliminate sparking and oscillations when the circuit is broken.

Conclusion.—The results show that iron, when brought to the zero point along any hysteresis curve, is in a definite state of magnetisation, even though neutral. In this condition the iron has a greater permeability than when it is demagnetised to the zero point by slow reversals of a gradually decreasing magnetomotive force.

AUTHORS.

1100. *Magnetic Observations at Buenos Ayres during the Annular Eclipse of the Sun, December 3, 1918.* **J. Ubach.** (Comptes Rendus, 169. pp. 733–735, Oct. 27, 1919.)—Frequent observations of declination were made, using a Chasselon magnetometer. A table gives the readings of the instrument at intervals of 5 mins. for a period of 3¾ hours covering the whole of the eclipse, together with the values to be expected under normal conditions. At the commencement of the eclipse the needle showed a westerly variation from the normal which increased until the eclipse was a maximum, when the return to the east began slowly at first and then more rapidly until the normal position was attained at the end of the eclipse. The striking agreement between the march of the solar and magnetic phenomena is thought to point strongly to a connection in spite of the day being otherwise disturbed magnetically, especially

about half an hour after the end of the eclipse. Observations at Santa-Fe, too, on the same occasion revealed a similar behaviour of the needle.
M. A. G.

1101. *Magnetic Susceptibility of Antimony and Bismuth.* **H. Isnardi** and **R. Gans.** (Univ. de la Plata Publ. [Mat. Fis. Ser.] 2. p. 69, 1917. Ann. d. Physik, 61. 7. pp. 585–590, April 15, 1920.)—The experimental investigations of Honda and M. Owen show that the specific susceptibility of Sb and Bi are not independent of the field intensity. This is contrary to the Langevin kinetic theory of magnetism. In the Gans theory if the principal moments of inertia of the magneton are equal the susceptibility should be independent of the field strength. The authors have measured the specific susceptibility of Sb and Bi in fields from 1000 to 15,000 c.g.s. units and find a constant value. The results of Honda and Owen are probably due to the presence of small quantities of iron. L. L.

RADIOGRAPHY AND ELECTROPHYSIOLOGY.

1102. *A Method of Testing an X-ray Tube for Definition.* **J. Brooksbank.** (Faraday Soc., Trans. 15. pp. 60–70; Disc., 70–71, Feb., 1920.)—The method consists in radiographing two uniform parallel wires of a given thickness and fixed at a definite distance apart. The distance between the photographic plate and the antikathode of the tube is kept constant whilst that between the plate and wires is varied. As the distance from the plate is increased the image of the wires becomes less and less distinct on the radiograph until finally at a critical position they can no longer be distinguished from one another. This critical position was taken as a measure of the definition of the tube. In the *discussion,* **C. E. S. Phillips** said that he had found the method useful in practice. In the apparatus as used by him two parallel needles were placed 0·2 mm. apart and were held upon a ring at the end of an arm which was interposed between plate and tube, and which could be automatically adjusted by means of a cam mechanism to stand at different heights above the plate. By comparing the radiographic results obtained with the needles at 5, 10, and 15 cm. respectively it was possible to classify the tube as having a fine, medium, or broad focus. Personal error was reduced to a minimum by the method, for it was not a case of relative sharpness but simply whether the line of demarcation between the two needles could be seen or not. The definition could be varied slightly by keeping the current constant and altering the hardness of the tube. E. A. O.

1103. *Action of Kathode Rays on Living Tissue.* **W. E. Pauli** and **J. Grober.** (Phys. Zeits. 21. pp. 148–150, March 15, 1920.)—The authors discuss the factors influencing the efficacy of different kinds of radiations (X-rays, radium rays, etc.) in relation to their effects on living tissue. The view seems to be held that the important factor is the amount of energy *absorbed* by the tissue. In this respect kathode rays possess obvious advantages. The results of investigation are as follows :—(1) For equal amounts of energy supplied by the induction coil the useful energy in the absorbing medium is 4×10^6 times greater for kathode rays than for X-rays. (2) The results of experiment give, in agreement with theory, a much greater action on living tissue in the case of kathode rays than in the case of X-rays. A. B. W.

CHEMICAL PHYSICS AND ELECTRO-CHEMISTRY.

1104. *Sorption of Vapours by Charcoal.* **B. Gustafson.** (Ark. f. Kem., Min. och Geol. Stockholm, 7. [pp. 1–17], 1918–1919.)—The sorption at 20° of the vapours of water and acetic acid by charcoal (kind not stated), which had previously been heated at 400° and evacuated, has been studied. The amount of sorption occurring at different pressures was determined by measuring the increase in weight of the glass bulb containing the charcoal, the apparatus being so arranged that this bulb could easily be detached. With water-vapour the sorption (ratio of the weight of vapour sorbed to the weight of charcoal taken) is directly proportional to the pressure for pressures up to about 5 mm., that is, the sorption is really solution. Above this pressure the straight-line curve changes to the usual adsorption curve. In all cases the two extrapolated curves cut at a pressure of 7·4 mm. Measurements of the velocity of sorption showed that the vapour is taken up most quickly at low pressures; the velocities are not in accordance with the equation $dx/dt = k(X - x)$, X being the equilibrium quantity of vapour and x the amount sorbed at time t. Equilibrium is very rapidly obtained by the reduction of pressure on charcoal containing sorbed water-vapour; this "equilibrium from below" has slightly lower values than that "from above." With acetic acid vapour sorption takes place very rapidly, and the straight-line curve holds only up to 0·8 mm. pressure. The "equilibrium from below" has markedly lower values than that obtained "from above," there being decided hysteresis, which can be explained as due to the two processes, solid solution and absorption. Charcoal which has not been outgassed at 400° gives lower equilibrium values than outgassed charcoal, the curves running approximately parallel. T. S. P.

1105. *Crystallisation of a Radium-Barium Solution.* **C. E. Scholl.** (Am. Chem. Soc., J. 42. pp. 889–896, May, 1920.)—Several systems of crystallising a radium-barium solution are given with a modified form that is very efficient in crystallising high-grade radium. The bromide system is more efficient than the chloride system. Radium is much easier to separate from barium than was formerly supposed. Several important conditions of crystallisation are noted. A. B. W.

1106. *X-Ray Examination of Steel.* **R. Hadfield, S. A. Main,** and **J. Brooksbank.** (Faraday Soc., Trans. 15. pp. 72–73, Feb., 1920.)—The great metallurgical possibilities of X-ray examination are limited by the penetrability of the masses of metal; 4 in. seems to be the max. thickness of steel so far penetrated. The non-destructive character of the test is a great advantage; but the apparatus required is costly and delicate, and microscopic defects are not magnified; fluorescent screen methods should in general be able to replace photographic methods. The X-rays might elucidate the allotropy problem. H. B.

1107. *Absorption Power of Different Steel for X-Rays.* **R. Hadfield, S. A. Main, and J. Brooksbank.** (Faraday Soc., Trans. 15. pp. 74–75, Feb., 1920.)—Reproduction of some radiographs of discs of steels, quenched or annealed, illustrating early experiments on distinguishing different steels. H. B.

1108. *Radiographs of Carbon Electrodes for Steel Furnaces.* **R. Hadfield and S. A. Main.** (Faraday Soc., Trans. 15. pp. 76-81; Disc., 82-88, Feb., 1920.)—Reproductions are given of radiographs of electrodes up to 20 in. diam. taken also in the hope of discovering the cause of the fractures occurring, especially with amorphous carbons. The examination of amorphous and graphitic electrodes from several makers proved of considerable technical interest, and it is suggested that the X-rays would be useful in controlling the manufacture of the electrodes, as to composition, baking temperature, etc. H. B.

1109. *Physical Changes in Iron and Steel below the Thermal Critical Range.* **T. Jeffries.** (Am. Inst. Mining Eng., Bull. No. 128 [17 pp.], Feb., 1920.)—The changes in the tensile properties of iron and steel with rise of temperature are best explained by assuming a low-temperature allotrope in iron, the change from this to the one stable at higher temperatures being gradual up to 350° C. The temperature of max. tensile strength corresponds with that physical state in which both allotropes are present in about equal proportions. As the change occurs at low temperatures the "mechanical cohesion" serves to render it sluggish, unlike for instance the point A3. If there be this change the crystals viewed under the microscope at room temperature are pseudomorphs of those formed at higher temperature when the iron was in a different allotropic state. An excellent summary of work done on the discontinuities in physical and mechanical proportion of iron and steel below the point A1 is included. F. C. T.

1110. *Critical Ranges of some Commercial Nickel Steels.* **H. Scott.** (Am. Inst. Mining Eng., Bull No. 128 [17 pp.], Feb., 1920. Bureau of Standards, Bull. 16. pp. 195-214 [Sci. Papers No. 376], 1920.)—The critical range Ar3 and Ar3·2 is lowered nearly linearly to absolute zero by 34% Ni. The Ac3 point is shown most clearly with slow rates of heating, and the effect on this point of the usual proportions of Mn and Si is slight. The rate of heating has only a moderate effect up to 4% Ni. The Ac1 point is lowered by 10·5 deg. C., the Ar1 point by 21·5 deg. C., and the eutectoid ratio decreased by 0·042% C. for each 1% Ni added. The following figures indicate the temperature at which the Ac3 point is completed.

Carbon Contents.	0·0.	0·2.	0·4.	0·6.	0·8.
Nickel absent	935	855	800	770	750
2% Ni	880	815	765	735	725
4% Ni	830	770	725	710	700

F. C. T.

1111. *The Dilatation of the Copper-Antimony Alloys.* **P. Braesco.** (Comptes Rendus, 170. pp. 103-105, Jan. 12, 1920.)—The measurements made with Chevenard's apparatus gave the following results for the mean coefficient of dilatation between 100° and 300° C. :

Per cent. Sb :—	0	4	7	15	32	38·6	40	45	50	55	72	97	99
Dilatation × 10^6 :—	16·4	17·9	19·1	20·0	23·3	23·4	23·3	23·0	21·6	20·0	17·4	11·2	9·3

The values for antimony agglomerated with 3% silicate of soda and cast were 8·3 and 10·0 respectively. The quenched or annealed alloys gave essentially the same results. The alloys containing from 4 to 50% Sb show an abrupt increase of length at a certain temperature which is greatest, 0·62% of the length of the piece, with 38·6% Sb, corresponding to the compound Cu_3Sb, becoming zero for the compound Cu_2Sb. The general dilatation curves do not indicate either compound. F. C. T.

1112. *Theory of Unimolecular Reaction Velocities.* **S. Dushman.** (Frank. Inst., J. 189. pp. 515–518, April, 1920.)—On the assumption that the rate of dissociation of a gas, A_2, at any instant is proportional to the concentration of the gas in the undissociated (or molecular) state, it is shown that the fraction of A_2 converted into the atomic condition during any interval of time is independent of the concentration and hence independent of the frequency of collision between the molecules; in other words, the value of the reaction-velocity constant (k_2) is dependent only on the temperature and on the internal structure of the molecule. Certain other considerations lead to the equation, $K_2 = \frac{Q}{Nh} \epsilon^{-Q/RT}$, where Q is the heat of dissociation per mol of A_2. N is the number of molecules per mol and is equal to $6 \cdot 062 \times 10^{23}$, and h is Planck's quantum constant. This equation, which indicates that the rate at which the molecules A_2 dissociate depends only on the heat of dissociation and on the temperature, is found by Langmuir to be applicable to the phenomena of evaporation and electron emission. The only unimolecular reaction of which the velocity-constant has been measured directly is the dissociation of PH_3, and for this Trautz and Bhandarkar [Zeitschr. Anorg. Chem., 106. pp. 95–125, 1919] found the value $10 \cdot 2 \times 10^{-3}$ for K_2 at $T = 495°$ and the value 70,000–80,000 cals. for Q; the above equation gives for Q the value 72,800 cals., the agreement being thus satisfactory.

The validity of the equation may be checked indirectly from determinations of the equilibrium constants and considerations based on the kinetic theory of gases, and the values thus obtained for the heats of dissociation of hydrogen, iodine, bromine, and chlorine agree well with those yielded by the equation itself. T. H. P.

1113. *Light-Electric Investigations on Salt Solutions.* **T. Swensson.** (Ark. f. Kem., Min. och Geol., Stockholm, 7. pp. 1–142, 1918–1919.)—After an historical survey of this question, the author describes his own comprehensive experiments, the results of which are briefly as follows :—

When various simple salt solutions are subjected to ultra-violet radiation, their potential with reference to an unattackable electrode undergoes change, the latter depending on the nature of the salt. When the illumination ceases, the potential changes towards its original value. In the potential-time curves maxima, minima, and inflection points occur.

A theoretical equation is developed and is found to be in agreement with the results obtained with a number of salt solutions, the electrodes being non-illuminated. In experiments with nitrogen, the only action of the latter is to mix the liquid through which it is passed. The effect is not caused by formation of ozone or hydrogen peroxide, and it does not require illumination of the electrodes.

The dependence of the effect on the intensity of the light has been investigated by means of nickel sulphate solution and the constants of the formula determined. As regards the concentration, it is shown that, theoretically the effect is either directly proportional to the concentration or independent of it, according to the relation of the intensity of the illumination to the concentration; both cases have been realised experimentally. The change of potential after the illumination ceases also corresponds with that deduced theoretically.

With sulphuric acid and potassium dichromate solutions separately the potential decreases, whereas with a mixture of the two an increase occurs. Here, too, illumination of the electrodes is unnecessary, and the change of potential is independent of the concentration but dependent on the composition of the solution. When the illumination ceases the potential recedes to the value it has in the dark; the velocity of this change depends on the composition and appears to be greatest for sulphuric acid, while it varies considerably with the temperature.

With alkaline solutions of potassium ferrocyanide and ferricyanide, a photochemical process takes place which alters the dark-potential.

The results obtained are discussed in relation to theoretical considerations which have been advanced. It is assumed that all substances in a system exhibiting electromotor activity are able to change their potential under the influence of light of certain wave-length owing to alteration of their energy-state, this alteration representing the primary photochemical process. The change of potential observed is directly proportional to the concentration of the atomic complexes influenced by the radiation. With infinite resistance a stationary equilibrium is reached in consequence of the conversion of the light-form into the normal form. With a finite resistance a part of the light-form is used up in the formation of the current and the change of concentration of the light-form is directly proportional to the current strength. The formula deduced on the basis of these assumptions shows the dependency of the potential on the resistance and the independency of the current strength in certain cases. T. H. P.